

CLAIMS:

1. An optical scanning device for scanning a multi-layer optical record carrier when positioned in a scanning location in the device, the device being adapted for scanning a first information layer at a first information layer depth within the record carrier and a second information layer at a second information layer depth within the record carrier, the device comprising:
 - a radiation source for generating a radiation beam;
 - an objective lens, located in an optical path between the radiation source and the scanning location, for converging a radiation beam to a spot on an information layer; and
 - an optical switching arrangement switchable between a first state, in which the device is arranged to scan a said first information layer, and a second state, in which the device is arranged to scan a said second information layer,

wherein the optical switching arrangement comprises a compensator arranged to generate a different amount of spherical aberration in a radiation beam when in said first state and when in said second state,

characterised in that the compensator is further arranged to generate a different amount of vergence in a radiation beam when in said first state and when in said second state,

 - the different amounts of spherical aberration and vergence being selected such that a free working distance between said objective lens and said optical record carrier remains substantially constant when switching between said first and second states.
2. An optical scanning device according to claim 1, wherein a change in free working distance (Δf_{wd}) when switching between said first and second states is less than 5% of a difference (Δd) in the first and second information layer depths.
3. An optical scanning device according to claim 2, wherein the change in free working distance (Δf_{wd}) is less than 1% of the difference (Δd) in the first and second information layer depths.
4. An optical scanning device according to any preceding claim, wherein a change in free working distance (Δf_{wd}) when switching between said first and second states is less than a focal tolerance Δz :

$$\Delta z = 0.5 \frac{\lambda}{NA^2}$$

where λ is the wavelength of the said radiation beam and NA the numerical aperture of the objective lens.

5. An optical scanning device according to any preceding claim, wherein said compensator comprises a set of fluids having a switchable configuration.
6. An optical scanning device according to claim 5, wherein said set of fluids provides a fluid meniscus of which the shape is varied when switching between said first and second states to provide the different amounts of spherical aberration and vergence.
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7. An optical scanning device according to any of claims 1 to 4, wherein said compensator comprises a grating element arranged to provide the different amounts of spherical aberration and vergence.
- 15 8. An optical scanning device according to any of claims 1 to 4, wherein said compensator comprises a phase structure having a non-periodic pattern which does not regularly repeat in a radial direction on the compensator, the phase structure being arranged to provide the different amounts of spherical aberration and vergence.
- 20 9. A method of operating the optical scanning device of any preceding claim, comprising reading data from the record carrier during a scanning operation conducted on one information layer, and altering the optical characteristics of the optical switching arrangement in order to compensate for a wavefront aberration generated in the record carrier when conducting a subsequent scanning operation on the other layer.
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10. A method of operating the optical scanning device of any of claims 1 to 8, comprising writing data to the record carrier during a scanning operation conducted on one information layer, and altering the optical characteristics of the optical switching arrangement in order to compensate for a wavefront aberration generated in the record carrier when
30 conducting a subsequent scanning operation on the other information layer.
11. An optical element adapted for use in an optical scanning device for scanning a multi-layer optical record carrier when positioned in a scanning location in the device, the device being adapted for scanning a first information layer at a first information layer depth

within the record carrier and a second information layer at a second information layer depth within the record carrier, the device comprising:

- a radiation source for generating a radiation beam;
- an objective lens, located in an optical path between the radiation source and
- 5 the scanning location, for converging a radiation beam to a spot on an information layer; and
- an optical switching arrangement switchable between a first state, in which the device is arranged to scan a said first information layer, and a second state, in which the device is arranged to scan a said second information layer,
- wherein the optical element is arranged to be included in said switching
- 10 arrangement and to generate a different amount of spherical aberration in a radiation beam when the optical switching arrangement is in said first state and when in said second state,
- characterised in that the optical element is further arranged to generate a different amount of vergence in a radiation beam when in said first state and when in said second state,
- 15 - the different amounts of spherical aberration and vergence being selected such that a free working distance between said objective lens and said optical record carrier remains substantially constant when switching between said first and second states.